Summary of Research Report
Cooperative Agreement
#NCC2-648

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Submitted by
American Technology Alliances (AmTech)

Overview

During the period of performance, AmTech was requested by the Technical Monitor of the Cooperative Agreement to closely coordinate its activities with the Ames Commercial Technology Office (CTO). In prior periods, more discretion concerning the focus of the activities was afforded AmTech; during this period, however, AmTech was instructed to be highly responsive to the specific objectives, projects, and processes of the CTO. Thus, with two exceptions, the Telemedicine Project and the Bootstrap Alliance, AmTech focused its efforts in areas designated by the CTO.

At CTO's request, AmTech regularly participated with that office in its management meetings. Although not reported on herein as a distinct area of activity, it should be noted for the record that a significant degree of effort was expended in that vein.

Areas of Activity

(1) Software Commercialization Center

(2) Natural Hazards

(3) Telemedicine Project

(4) Commercialization

- (a) Pulse Tube Refrigeration
- (b) Video Compression
- (c) Liquid Crystal Shear Stress Measurement
- (d) Adaptive Engine

(5) Discovery Project

(6) Bootstrap Alliance

Software Commercialization Center

AmTech worked with a designated CTO representative to undertake a feasibility investigation for a software commercialization and development center to be located at Ames. This concept seems to have arisen from a proposal made by AmTech to CTO that a specific process be adopted to mine for and commercialize software developed by or for ARC. The AmTech concept evolved into a grander notion of a software commercialization center.

The original concept was prompted by a perceived lack of an organized system for identifying and managing valuable software assets. As ARC became designated the Center of Excellence for Information Technology, the interest became keen in focusing on digital technology assets of interest to the commercial sector. The feasibility study AmTech undertook initially involved a concept plan for such a Software Center. AmTech developed a notional plan for attracting participation from Ames researchers, in order to develop a meaningful repository of software assets, as well as a plan for offering the software to the commercial sector for licensing or joint development with Ames.

At the request of the CTO Director, the scope of AmTech's work included managing a CTO-designated subcontractor, Flagg Inc., engaged to assist in the investigation. Following delivery of the preliminary concept, much of AmTech work involved reformulation of the plans in light of emerging requirements of potential funding sources from NASA HQ. Thus, numerous formats for the organization were developed to address multiple funding scenarios.

Findings of the investigation included the following:

--Implementation of any plan for a software commercialization center hinged on obtaining virtually complete cooperation and involvement from the developers of software within the Ames Research Center. Expectations of achieving this were not rated highly, as many researchers not only did not possess an interest in commercialization, but actively considered their work product to be freely available to the private sector. In addition, researchers routinely disseminated software through undocumented transfers, such as conferences, person-to-person contact, and via the internet.

--The Ames Research Center in fact possessed a more limited stock of software with commercial potential than originally conceived. Thus, it was questionable whether the Software Center could sustain operations over time based on ARC as a source of software.

--The appeal of Ames Research Center developed software to commercial parties was dependent in large part on the availability of supporting documentation, which was notoriously lacking.

--Evidence showed that commercial parties would insist on direct access to the software developer for purposes of evaluating the commercial and possible further enhancements. The relative unavailability of the NASA researcher for such purposes was identified as an inhibiting factor.

--AmTech's interactions with software developers revealed some willingness on their part to act as advisors to NASA regarding the commercial potential of ARC developed software. However, these same parties expressed skepticism about the probability of a NASA-based software center becoming a significant source of commercially valuable software.

AmTech met frequently with the CTO representative to this project, as well as the Technical Contract Monitor and the Director of CTO to brief results and discuss next steps. Due to the lack of clear funding for the effort, and some of the feasibility concerns identified during the study, the CTO eventually suspended continuing efforts to form the Software Center. AmTech was instructed to cease work on this project.

Telemedicine

At CTO's request, AmTech undertook to study the lack of movement occurring in an existing consortium, known as HOST (Health Care Open Systems and Trials). HOST had been formed during the prior year by industry and government members, including NASA, and later became an independent, non-profit organization. After preliminary contact, AmTech suggested that there might be an opportunity to use the HOST members as a source for recruiting a commercial partner for joint R&D activities with ARC researchers. Thus, AmTech prepared packages of information on various technologies and disseminated them over 20 companies and institutions, with the result that one company, Unitron Corp., developed a serious interest in the telemetric capabilities resident within the ARC Sensors 2000 Project. As a result of the company's expressed interest, AmTech sought and gained approval to undertake preliminary project development work for the purpose of laying the groundwork for formation of a Joint Sponsored Research Agreement for joint development of sensor technology for telemedicine applications.

AmTech's exploration of the potential for joint work with Unitron revealed a number of salient points:

--the company was in a beta-test mode with its existing system, and considered the NASA telemetric capability a potentially powerful agent to enlarge the family of health-care monitoring devices which could be connected to its system;

--there was a functional parallel between the anticipated NASA and commercial uses of the telemetric capability, so that joint work could justifiably be characterized as dual use.

Although the definition of technical requirements by the company was slowed by its process of assessing which markets and capabilities would be most important to developing a pre-emptive position in the market, sufficient convergence existed among NASA and Unitron to warrant a joint R&D relationship. Thus, in the fall of 1996, AmTech journeyed with Dr. John Hines of NASA Ames to Unitron's offices in Florida to detail the terms and conditions of a joint effort. Thereafter, AmTech drafted a Joint Sponsored Reseach Agreement (JSRA), which called for a flow of NASA and commercial funds to project-related work of mutual benefit and interest.

Following execution of the JSRA, the CTO informed AmTech it would no longer support its role as Facilitator between NASA and Unitron, despite appeals to the contrary by Dr. Hines and Unitron. The CTO's reasoning was that it could play the role of Facilitator, utilizing civil servant staff, rather than paying for AmTech's involvement.

Despite the lack of continuing funding support, AmTech continued to meet with Dr. Hines and Unitron in an unofficial capacity, in order to track the progress of the partnership. AmTech witness that progress was slow, and the JSRA eventually expired without the desired working model having been achieved. Since AmTech was not officially engaged, it could not Facilitate the parties to a better outcome. The CTO did provide a civil servant representative as a point of contact for the partnership, but due to the individual's lack of knowledge concerning the underlying motivations of the partners, and more importantly, the lack of established trust between her and the partners, there was arguably more friction than benefit derived from the interaction.

Despite the lack of technical closure on this project, the market dynamics and technical requirement of the evolving health care information systems imply potential for Ames-based information technologies. (As an interesting sidenote, after the expiration of this Cooperative Agreement, Unitron Corp. engaged AmTech directly for help in technology commercialization. Unitron also elected to try again to work with Dr. Hines on completion of the sensor model).

Discovery Process

The CTO recognized a need to establish a database of technologies resident at Ames in order to foster commercialization. Since no database was yet in existence, it was determined that an effort should be made to canvas researchers in the various technical codes to gather this information. However, there was also an awareness within CTO that researchers often did not give commercialization efforts much assistance and some were actually hostile. The CTO called upon AmTech to

develop a discovery interview process and training program for CTO interviewers. AmTech developed a training program for CTO staff so those individuals who were relative newcomers to technology commercialization (i.e., most of the staff) could develop the skills necessary to establish rapport with researchers and gather useful information on the status of technologies. AmTech delivered a written training program and provided instruction to approximately 15 CTO staff members. AmTech also provided suggestions to the CTO on the appropriate database format with which to compile information.

During an interval of approximately 6 months, AmTech conducted interviews with branch chiefs and researchers at ARC and compiled the technology information in the established CTO database format. Approximately 58 interviews were conducted overall, of which AmTech conducted 26.

As the interview process wound to a close, CTO staff considered input from AmTech and its own interviewers on the commercial potential of the technologies compiled, and requested that AmTech do a more in-depth assessment of their commercial possibilities. The technologies approved for further investigation were: (i) a software tool called the adaptive engine; (ii) image compression software; (iii) a liquid crystal shear stress measurement system; (iv) and pulse tube refrigeration technology. These individual investigations are summarized in greater detail in the following 4 sections.

Image Compression Technology

This technology was developed by Dr. Andrew Watson at Ames. The chief advantages of the particular technique developed by Dr. Watson were that a) it was based on scientifically gathered data which permitted trading-off a given degree of data compression against a predictable measure of perceptual resolution; and b) the method of compression was not feature-dependent, so that the same technique could be applied to a string of images with fundamentally different composition with no need for adjustment.

AmTech found in its investigation that image compression methods are legion, but the JPEG technique, which is available to the public, is the most widely used for open communications. In closed systems, there are dozens of approaches having a wide array of claimed benefits, thus making it somewhat difficult to readily compare various methodologies. Despite the difficulty of evaluation, AmTech identified Tau Corporation of Los Gatos as commercial party potentially interested in Dr. Watson's image compression methodology and arranged a series of conferences which led to a trials by Dr. Watson of images supplied by the company. Although the company did see satisfactory results, their initial evaluation was that the degree of compression afforded was not sufficient to warrant further investigation. No other company candidates were identified during the investigation.

Adaptive Engine Software

This technology consisted of software which imparts the ability to establish relevance-based retrieval in the handling of large repositories of information. It is especially suited to task-based inquiries. The inventing researchers of the software are Natalie Mathe and James Chen. AmTech identified this software as a key information technology with the potential to dramatically alter access to information in many commercial fields, and stressed its importance to CTO staff members. AmTech also acted promptly in arranging for the researchers to file an invention disclosure with the Ames patent counsel in order to protect its proprietariness. This action averted an undocumented transfer to the public, which the researchers were strongly considering via the posting of the software on an internet site.

This investigation afforded examples of two obstacles previously mentioned in connection with the software commercialization center project described earlier in this summary. First, the researchers had published the workings of their software in a paper delivered almost a year earlier, so that by the time the disclosure was completed, patent protection of the software was no longer available. Second, the fact that both developers were contractors and had changed contracting employers over the course of the software's development created a tangle of rights which were extremely difficult for the patent counsel's office to sort out. This issue became moot once the right to patent was found to have expired, but nevertheless drew attention to ARC's need to more closely track rights of developers.

Pulse Tube Refrigeration

This method of achieving cryogenic temperatures was determined not to be patentable at the stage of development being worked by the researchers at the time of investigation. The researchers involved included Peter Kittel, Pat Roach, Geoffrey Lee, and Ali Kashani. However, because of its potential to offer high reliability with no moving parts, the expertise of the research team was considered valuable in a commercial context and worthy of efforts to identify a commercial partner.

AmTech contacted numerous companies in the Bay Area, including in-person meetings with representatives of Thermionics, Varian, and Perkin-Elmer. In addition, the entire set of companies in California which had attended a conference at Ames on pulse tube refrigeration was contacted, approximately 15 companies in all. On behalf of the researchers, AmTech attended the 1996 Cryocooler Conference and facilitated a discussion session including six industry companies and one university, for the purpose of proposing a partnership with ARC.

AmTech determined that three main factors were retarding the adoption of this technology for its many applications and interest in partnership with ARC. The first

is the fact that the cryocooler industry is very fragmented according to user applications, so that each cooler needs to be custom-tailored to a particular situation. This factor tends to keep unit costs high, which make the pulse tube unit less competitive with conventional methods. Second, since the reliability of the pulse tube unit is very high, the role of the driving compressor in maintaining system reliability becomes much more visible. As it stands, the compressor industry is in stable equilibrium, with no innovations on the horizon that would afford a comparable match with the pulse tube refrigerator. Development costs for pushing compressor technology to higher levels are not justified at the present time, according to the industry sources contacted. The third factor was the probable lack of patent protection for any commercial adaptations of the technology. The pulse tube refrigeration phenomenon goes back to the mid-60s, and any original patents have since expired. There have been patents filed by Japanese and domestic inventors in the 1990s covering various pulse tube devices. However, there would be nothing to prevent competitors in the market from copying a successful adaptation for a particular application. Thus, initially efforts to identify commercial partners did not result in enduring expressions of interest by commercial parties.

AmTech furnished background information to the ARC researchers concerning the status of their technology relative to the market. The researchers used this information to formulate an application for funds to the CTO. The CTO granted their application for funds through its own project selection process.

Liquid Crystal Shear Stress Measurement

This technology was developed by Ames researcher Dan Reda for the purpose of measuring skin friction drag on wind tunnel models. It involves coating a model with a liquid crystal material and then illuminating the model during a wind tunnel test. The light would then be reflected in a manner such that the degree of shear stress was indicated by the color of light transmitted. This method was novel in that it permitted capturing a color-coded image which, when processed with appropriate software, could be used to measure and integrate to obtain skin friction drag forces.

AmTech first addressed the issue of whether this technique represented a functional advance from the perspective of users of existing wind tunnel methodologies. It was determined that wind tunnel operators at the large aerospace firms had an alternative, existing method of determining skin friction drag via a full-force measurement with instrumented pylons that supported the wind tunnel model. There was apparently a substantial comfort level with this technique, due to the large body of data derived from it, and the good predictability it has offered. Most of the individuals contacted were nevertheless open to learning about the liquid crystal shear stress technique. AmTech provided these people with background technical papers previously presented by researcher Reda at professional seminars, and arranged for telephone follow-up by the researcher as appropriate.

After the recipients of information had had time to digest the concept, they were contacted for follow-up discussions. Points mentioned as tending to discourage exploration of the at that time included the following: 1) Adoption appeared to require some modifications to the wind tunnel facility itself in order to meet the operating constraints of the technology. 2) Wind tunnel researchers were not expressing dissatisfaction with the techniques already in use. 3) The technique would require a substantial investment in understanding in order to gain confidence comparable with conventional methods. 4) Researchers already felt their budgets were being squeezed, and had a preference for using any scarce resources to retain or increase staff, as opposed to invest in a new technology.

It is worth mentioning that none of the wind tunnel researchers contacted at the large aerospace firms disputed the technical advantages which the liquid crystal shear stress technique appeared to have. The lack of motivation to carry exploration further was clearly based more on the economic conditions facing the researchers.

In addition to aerospace firms, AmTech contacted a number of companies involved in the designing and building of high-speed race cars, such as the Formula 1 cars used at the Indianapolis 500 Memorial Day race. This was done at the behest of the researcher, who had mentioned receiving some inquiries from these firms. Despite the not-insignificant efforts to register a reaction to the liquid crystal technology, there was insufficient response to generalize. This result appeared to be due mostly to a lack of focus on skin friction as an issue in the design and building of race cars.

Natural Hazards

Natural Hazards is a broad applications area that encompasses the anticipation, prevention, and recovery from losses to life and property as a result of wind, fire, flood, and/or seismic activity. The technologies resident at Ames with potential application to the reduction of natural hazards cut across a number of different disciplines. These include, but are not limited to, in-flight data and image acquisition, remote imaging via satellites, sensors, simulation, and information technologies. Initially, AmTech was asked to assist a member of the CTO who had become involved in an ad hoc group which referred to itself as the Natural Hazards Consortium. This group, which consisted of most of the major defense-oriented aerospace firms in the State, had responded to a call from the Seismic Safety Commission of the State of California for industry to come together and find new ways to incorporate emerging technologies in the infrastructure of natural hazards mitigation. Their plan, which the SSC initially supported, was to develop a joint proposal which could be used as the basis for an appeal to FEMA for funding.

AmTech's repeated contacts with both the Director of the SSC and the companies eventually revealed that the thrust of the NHC members' effort was not responsive to the SSC's objectives. AmTech facilitated dialogue between the SSC and NHC in an attempt to make the efforts of the parties' synergistic. The concern of the SSC

was that the NHC proposal then being formulated consisted more of a rehash of conventional projects and technologies looking for a home, as opposed to a ground-up review of the needs of the natural hazards mitigation community. When the NHC failed to respond to the SSC's direct advice and AmTech's facilitative efforts, the SSC distanced itself from the activities of the NHC. AmTech researched the technologies and capabilities resident at Ames, and found the potential for some contribution to natural hazards mitigation. AmTech found no immediate partnering interest in development of the technology, however. The SSC, although very receptive to AmTech's information about Ames, did not have a budget to fund technology development or demonstration. On the commercial side, there did not exist any identifiable industry sector dedicated to natural hazard mitigation; thus, the degree of effort required to identify companies involved in hazard mitigation and possibly receptive to partnering with Ames was gauged by AmTech and Ames' CTO staff to be too great for the return on the investment. Consequently, AmTech's efforts in this vein were halted. However, AmTech was invited to address a meeting of the Defense Space Consortium at which the DSC and community groups were contemplating possible uses of the "Blue Cube" facilities at the recently decommissioned Moffett Naval Air Station. AmTech drew upon its knowledge of hazard mitigation requirements to suggest that the Blue Cube could serve as the coordination point for a myriad of hazard reaction services. This suggestion was later incorporated by the DSC into a proposal made to the State of California.

Bootstrap Alliance

The designation of Ames as the NASA Center of Excellence for Information Technologies raised the potential for a connection between the Center and a developmental effort being undertaken by Dr. Douglas Engelbart, inventor of the computer mouse, and industry members, including Sun Microsystems, Netscape, and ETS (Educational Testing Service).

Dr. Engelbart and the above industry members privately engaged AmTech as Business Manager for a newly forming nonprofit organization, the Bootstrap Alliance, whose mission is to promote the use of digital technologies for collaborative problem solving. Dr. Engelbart is recognized as a world leader in digital technology and various theories concerning the next generation of capabilities and applications. AmTech informed Dr. Engelbart and the representatives of Sun, Netscape and ETS (all Directors of technology) about Ames' aspirations to become a Center of Excellence for Information Technology, and to play a key part in the continued success of the Silicon Valley. Thereafter, AmTech arranged an exploratory meeting between members of the Center of Excellence and the Bootstrap Alliance principals to investigate areas of mutual interest.

Specifically, AmTech arranged for a briefing by Dr. Engelbart and Dr. Jeff Rulifson, Director of Technology for Sun Microsystems, toDr. Jack Hanson of the Ames COE/IT and representatives from counterpart organizations at Goddard and JPL.

Following the meeting, Dr. Hanson expressed an interest in identifying specific, concrete projects which could advance the progress of the NASA enterprise missions under way at Ames. Dr. Engelbart was receptive to a follow-up meeting to further examine the benefits of joint interaction. However, Dr. Hanson's schedule caused him to cancel several appointments arranged by AmTech, and ultimately, the grant expired before Dr. Hanson became available.

End of Summary